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(71) Applicant: **KITZ CORPORATION**
1-10-1 Nakase,
Mihama-ku
Chiba-shi,
Chiba-ken (JP)
Applicant: **NIPPON PILLAR PACKING CO. LTD.**
11-48 Nonakaminami 2-chome
Yodogawa-ku
Osaka-shi
Osaka-fu (JP)

(72) Inventor: **Naitou, Kazumasa, c/o Kitz Corporation**
Nagasaka Fact.,
2040 Nagasakakamijo,
Nagasaka-cho
Kitakoma-gun,
Yamanashi-ken (JP)
Inventor: **Naito, Shosuke, c/o Kitz Corporation**
Nagasaka Fact.,
2040 Nagasakakamijo,
Nagasaka-cho
Kitakoma-gun,
Yamanashi-ken (JP)
Inventor: **Ueda, Takahisa, c/o Nippon Pillar Pack. Co., Ltd.**
Sanda Fact.,
541-1 Aza Utsuba,
Shimo Uchigami
Sanda-shi,
Hyogo-ken (JP)
Inventor: **Fujiwara, Masaru, c/o Nippon Pillar Pack. Co., Ltd**
Sanda Fact.,
541-1 Aza Utsuba,
Shimo Uchigami
Sanda-shi,
Hyogo-ken (JP)

(74) Representative: **Gordon, Michael Vincent**
GILL JENNINGS & EVERY,
Broadgate House,
7 Eldon Street
London EC2M 7LH (GB)

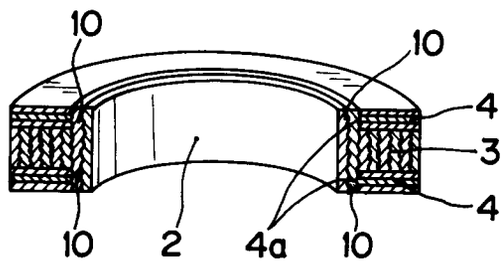
(54) Packing rings.

(57) A packing ring (2) is characterised by comprising:

a packing (3) obtained by spirally winding a ribbon of expanded graphite into a roll and compression moulding said roll; and

an annular mass (4) of superposed sheets of expanded graphite incorporated into said packing (3) by compression moulding so as to give rise to a composite structure having at least one packed part (10) of increased density in at least one of an inner peripheral part and an outer peripheral part of said packing.

FIG.1



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This invention relates primarily to packing rings but also relates to a method for the production of the packing rings as well as to seal devices using the packing rings.

Packing rings can be used extensively as seal members in parts prone mainly to rotary or reciprocating sliding motions or indeed in stationary parts. For example, they can be used in a seal device to be interposed between the body or bonnet and the stem of a valve or in a seal device for fluid-handling devices and to be incorporated in a pump shaft sealing part etc. Examples of the fluids for which the packing rings are effectively used include gases, liquids and loose solid materials. Particularly in recent years, the free emission of fluids from the fluid-handling devices has been posing a serious problem from the standpoint of preservation of the earth's environment. From this point of view, there is a great demand for developing packing rings which excel in heat resistance and chemical resistance as well as in sealing.

The packing rings are generally known in two types.

Those of one type are produced by cutting a ribbon from a sheet of expanded graphite, winding the ribbon into a spiral roll and compression moulding the roll annularly in a die, and those of the other type are produced by laminating a plurality of sheets of expanded graphite and punching a ring of prescribed dimensions out of the resultant lamination.

The packing rings of the two types are inserted in an empty space adapted for accommodation thereof and then compressed therein prior to use.

In the case of the packing rings of the former type, since they easily deform laterally, namely in the radial direction, under the force of the compression, they gain in force of contact with a stuffing box or a shaft and consequently manifest a sufficient sealing function even when the stuffing box or the shaft lacks dimensional accuracy. However, such satisfactory sealing function tends to decline with the elapse of time because the packing rings easily protrude through gaps such as occurring between the bottom surface of the stuffing box and the shaft, between the gland retainer and the shaft and between the gland retainer and the empty space of the stuffing box, and consequently entails a loss in the force of the compression.

Further, since the fastness of adhesion between the layers of the wound sheet material forming the packing rings is reduced rather than increased by the force of the compression exerted on the packing rings, the fluid being handled is liable to permeate the packing rings in the axial direction. Moreover, the surfaces of the packing rings which contact other packing rings, the bottom surface of the stuffing box, or the retaining surface of the gland retainer are formed of the end face of the sheet material which forms the packing rings. The packing rings thus betray poor fastness of adhesion on the surfaces in question and tend to get wet, and the surfaces themselves tend to sustain injury and demand delicate handling.

Then, in the case of the packing rings of the latter type, these packing rings do not gain very much in force of contact with the stuffing box or the shaft because the ratio at which the packing rings are deformed laterally, namely in the radial direction, under the force of the compression is very small. When the stuffing box or the shaft lacks accuracy of machining or dimensional accuracy, therefore, the packing rings tend to entail leakage of the fluid because of the poor fastness of adhesion. Fortunately, these packing rings preclude the permeation of fluid therethrough in the axial direction under the force of compression, manifest satisfactory fastness of adhesion thereof to the bottom surface of the stuffing box or to the retaining surface of the gland retainer, and permit no ready leakage of fluid through the interfaces. Further, these packing rings do not very often protrude through the empty space for accommodating the packing rings, namely through the gap between the bottom part of the stuffing box and the shaft, the gap between the gland retainer and the shaft and the gap between the gland retainer and the stuffing box. The possibility that the packing rings will protrude to the extent of degrading the force of compression and sacrificing the sealing function is remote.

These packing rings are at a disadvantage in entailing easy vertical separation between the layers of laminated sheet material, readily sustaining injury, demanding delicate handling, and calling for much time and labour for the sake of maintenance.

Figure 18 is a partial longitudinal cross-section illustrating a seal device which is disclosed in Japanese Utility Model Publication No. 1-29315 and which has been proposed for the purpose of utilizing packing rings of expanded graphite produced by the two methods described above while eliminating the drawbacks thereof and harnessing the advantages thereof.

In Figure 18, reference numerals 21 to 25 stand for packing rings of expanded graphite, specifically numerals 21 and 25 each stand for a packing ring produced by the latter of the two methods and numerals 22, 23 and 24 each stand for a packing ring produced by the former method, also numeral 26 stands for a stuffing box, numeral 27 for a stem, and numeral 28 for a gland retainer.

As illustrated in Figure 18, the packing rings 21 to 25 are compressed by the gland retainer 28 inside the stuffing box 26.

As a result, the packing rings 22, 23 and 24 produced by the former method are deformed in the radial direction and brought into tight contact with the stuffing box 26 and the stem 27 to preclude the otherwise possible leakage of fluid along the interfaces of the contact.

The packing rings 21 and 25, meanwhile, prevent leakage therethrough of fluid which might have permeated through the packing rings 22, 23 and 24 in the axial direction. Further, the packing rings 21 and 25 prevent leakage therethrough of fluid which might have flowed through the interfaces thereof with the packing rings 22 or 24, a bottom surface 26a of the stuffing box 26, and a retaining surface 28a of the gland retainer 28. Since the packing rings 21 and 25 are superposed in a direction which is perpendicular to a gap A between the bottom part of the stuffing box 26 and the stem 27, a gap B between the gland retainer 28 and the stem 27 and a gap C between the gland retainer 28 and the stuffing box 26, they are suffered to protrude through these gaps very rarely.

Even in the seal device which is constructed as illustrated in Figure 18, however, the packing rings 21 to 25 tend to sustain injury and demand delicate handling. Particularly, the packing rings 21 and 25 easily separate vertically from the intervening packing rings 22 to 24 and render the work of maintenance thereof difficult. Though they protrude through the aforementioned gaps A, B and C only slightly, such protrusion nevertheless remains a problem. Moreover, this seal device is at a disadvantage in insufficiently preventing leakage therethrough of a gas of small molecular weight or a solvent of strong osmosis.

One object of the present invention is thus to provide packing rings of expanded graphite capable of excellent heat resistance and chemical resistance and also capable of eliminating the drawbacks inherent in the conventional packing rings.

According to the present invention there is provided:-

a packing ring characterised by comprising: a packing obtained by spirally winding a ribbon of expanded graphite into a roll and compression moulding said roll; and an annular mass of superposed sheets of expanded graphite incorporated into said packing by compression moulding so as to give rise to a composite structure having at least one packed part of increased density in at least one of an inner peripheral part and an outer peripheral part of said packing;

a method for the production of a packing ring, characterised by comprising the steps of: spirally winding a ribbon of expanded graphite into a roll; compression moulding said roll into a packing; disposing an annular mass of superposed sheets of expanded graphite at a position in or against said packing; and compression moulding within a moulding die so as to give rise to a composite structure having at least one packed part of increased density in at least one of an inner peripheral part and an outer peripheral part of said packing; and

a seal device having an empty space through which a shaft passes, and containing at least one packing ring in said empty space in a compressed fashion to seal between an inner wall of said empty space and an outer peripheral surface of said shaft, said at least one packing ring being characterised by comprising a packing obtained by spirally winding a ribbon of expanded graphite into a roll and compression moulding said roll, and an annular mass of superposed sheets of expanded graphite incorporated into said packing by compression moulding so as to give rise to a composite structure having at least one packed part of increased density in at least one of an inner peripheral part and an outer peripheral part of said packing.

Several embodiments of the present invention, and an embodiment of the prior art, are shown, by way of example only, in the accompanying drawings wherein:-

Figures 1 to 10 are halved perspective views illustrating different examples of packing rings according to the present invention;

Figures 11 to 14 are sectioned explanatory views of the packing rings shown in Figures 1 to 4 respectively;

Figure 15 is a partial cross-section illustrating one example of a seal device according to the present invention;

Figure 16 is a partial cross-section illustrating another example of a seal device according to the present invention;

Figure 17 is a diagram representing the results of a test for comparison between the seal devices of the present invention and the seal devices of the prior art; and

Figure 18 is a partial cross-section illustrating one example of a prior art seal device.

In each of Figures 1 to 14, reference numeral 2 designates a packing ring - although the packing ring 2 is an endless ring, a cord-like packing adapted to be inserted in the shape of a ring in an empty space for accommodation of a packing ring may be used instead.

The packing ring 2 comprises a packing 3 formed by spirally winding a ribbon of expanded graphite into a roll and compression moulding the roll, and an annular mass 4 of superposed sheets of expanded graphite. The annular mass 4 has an inside diameter larger than the inside diameter of the packing 3 and/or has an outside diameter smaller than the outside diameter of the packing 3.

The packing rings 2 shown in Figures 1 to 14 are invariably composite structures having one or two annular masses 4 incorporated in the packing 3.

In all of the packing rings 2, the packing 3 is extended past either one or both of the inner peripheral part 4a and the outer peripheral part 4b of the annular mass 4. In other words, the packing 3 is driven to at least one of the inner and outer peripheral parts 4a and 4b of the annular mass 4 to give rise to a packed part 10 of a density higher than that of the packing 3. The packed part 10 is formed in a portion of the packing 3 resulting from the difference in diameter between the annular mass 4 and the packing 3.

In all of the packing rings 2, the packings 3 formed by spirally winding a ribbon of expanded graphite into a roll and compression moulding the roll have a density in the range of 0.7 to 1.9 g/cc, preferably in the range of 1.0 to 1.5 g/cc (1.3 g/cc, for example) and the annular masses 4 of superposed sheets of expanded graphite have a density in the range of 0.7 to 1.9 g/cc, preferably less than that of the packings 3.

The packing rings 2 are invariably produced by spirally winding a ribbon of expanded graphite into a roll, compression moulding the roll into a packing 3 having a predetermined inside diameter and a predetermined outside diameter, disposing at least one annular mass 4 of superposed sheets of expanded graphite having a larger inside diameter than the packing 3 and/or having a smaller outside diameter than the packing 3 at a given position or positions in the packing 3, and compression moulding the resultant composite within a moulding die (not shown) so as to give rise to a packed part 10 of a density higher than that of the packing 3 in a portion of the packing 3 resulting from the difference in diameter between the annular mass 4 and the packing 3.

The packing rings 2 shown in Figures 1 to 4 have two annular masses 4 of superposed sheets of expanded graphite incorporated one each in the upper and lower surfaces of a packing 3, the packing rings 2 shown in Figures 5 to 7 have such a mass 4 incorporated in the intermediate part of the packing 3 in the direction of its thickness, and the packing rings 2 shown in Figures 8 to 10 have such a mass 4 incorporated in either the upper surface or the lower surface of the packing 3.

It is desirable to dispose an annular mass 4 of superposed sheets of expanded graphite on the inner peripheral part, the outer peripheral part, or each of both the inner and outer peripheral parts of a packing 3 formed by spirally winding a ribbon of expanded graphite into a roll and compression moulding the roll so as to give rise to a packed part 10 of a higher density in the relevant area.

To be specific, the packing ring shown in Figure 1 has a construction such that each of the annular masses 4 extends to the outer peripheral part of the packing 3, thereby giving rise to packed parts 10 of a density higher than that of the packing 3 in the relevant areas on the side of the inner peripheral part of the packing 3. The packing ring shown in Figure 2 has a construction such that each of the annular masses 4 extends to the inner peripheral part, thereby giving rise to packed parts 10 of a density higher than that of the packing 3 in the relevant areas on the side of the outer peripheral part of the packing 3. The packing ring shown in Figure 3 has a construction such that one of the annular masses 4 extends to the outer peripheral part of the packing 3 and the other annular mass 4 extends to the inner peripheral part of the packing 3, thereby giving rise to packed parts 10 having a higher density than the packing 3 in the relevant areas, one on the side of the inner peripheral part of the packing 3 and the other on the side of the outer peripheral part of the packing 3. The packing ring shown in Figure 4 has a construction such that each of the annular masses 4 extends to portions immediately before the inner and outer peripheral parts of the packing 3 so as to give rise to packed parts 10 having a higher density than the packing 3 in the relevant areas on both sides of the inner and outer peripheral parts of the upper and lower surfaces of the packing 3. These configurations of the packing rings shown in Figures 1 to 4 will be more clearly understood from Figures 11 to 14, respectively.

The packing ring shown in Figure 5 has a construction such that the mass 4 extends to the outer peripheral part of the packing 3, thereby giving rise to a packed part 10 of a density higher than that of the packing 3 in the relevant area on the side of the inner peripheral part of the packing 3. The packing ring 2 shown in Figure 6 has a construction such that the mass 4 extends to the inner peripheral part of the packing 3, thereby giving rise to a packed part 10 of a density higher than that of the packing 3 in the relevant area on the side of the outer peripheral part of the packing 3. The packing ring shown in Figure 7 has a construction such that the mass 4 extends immediately before the inner and outer peripheral parts of the packing 3, thereby giving rise to packed parts 10 of a density higher than that of the packing 3 in the relevant areas on both sides of the inner and outer peripheral parts of the packing 3.

The packing ring shown in Figure 8 has a construction such that the mass 4 extends to the outer peripheral parts of the packing 3, thereby giving rise to a packed part 10 of a density higher than that of the packing 3 in the relevant area on the side of the inner peripheral part of the packing

3. The packing ring illustrated in Figure 9 has a construction such that the mass 4 extends to the inner peripheral part of the packing 3, thereby giving rise to a packed part 10 having of a density higher than the packing 3 in the relevant area on the side of the outer peripheral part of the packing 3. The packing ring shown in Figure 10 has a construction such that the mass 4 extends immediately before the inner and outer peripheral parts of the packing 3, thereby giving rise to packed parts 10 of a density higher than that of the packing 3 in the relevant areas on both sides of the inner and outer peripheral parts of the packing 3.

Any of the measures mentioned above proves advantageous for the sake of this invention.

Figures 15 and 16 are partial cross-sections showing examples of a seal device 1 according to this invention.

In the seal device 1 shown in Figure 15, a packing ring 2 shown in Figures 2 or 12 is sandwiched between two packing rings 2 shown in Figures 1 or 11, and the three superposed packing rings 2 are sandwiched between two braided packing rings 5 formed by braiding a knitting yarn made of carbon fibres or expanded graphite. The plurality of superposed packing rings 2 and 5 are inserted into a stuffing box 8, i.e. an empty space adapted for accommodation thereof. In the seal device 1 thus constructed, the braided packing rings 5 are enabled to manifest the function of a wiper ring.

In the seal device 1 illustrated in Figure 16, three packing rings 2 shown in Figures 3 or 13 are superposed one on top of another and are sandwiched between two braided packing rings 5 formed by braiding a knitting yarn of expanded graphite. The plurality of superposed packing rings 2 and 5 are inserted into a stuffing box 8, i.e. an empty space adapted for accommodation thereof. In this case, the braided packing rings 5 are also enabled to manifest the function of a wiper ring. The seal device 1 thus constructed encounters no trouble pertaining to maintenance because the packing rings 2 of the same composite construction are not erroneously incorporated into the seal device 1 during the assembly of the seal device 1.

The seal device 1 illustrated in Figures 15 or 16 is desirably used in the shaft gland part of a pump (not shown) or in the seal part of a valve. In Figures 15 and 16, reference numeral 6 stands for the stem of the valve, numeral 7 for the body or bonnet of the valve, and numeral 9 for a gland retainer.

Now, the operation of the working example will be described below.

When the packing ring 2 of this invention, constructed as illustrated in Figures 1 to 14, is set in place inside the stuffing box 8 and then compressed with the gland retainer 9 as shown in Figures 15 and 16, the packings 3 formed by spirally winding a ribbon of expanded graphite into a roll and compression moulding the roll easily deform in the radial direction and consequently cause the inner and outer peripheral parts thereof to form a tight seal in a gap L between the stem 6 and the bottom part of the stuffing box 8 and prevent the otherwise possible leakage through this gap L and, at the same time, the annular masses 4 of superposed sheets of expanded graphite obstruct the possible fluid leakage in the axial direction through the interfaces between the component layers of the packings 3. Thus, these packing rings 2 serve as quite excellent seal members for precluding free emission of the fluids being handled in fluid-handling devices.

The packing ring 2 in the present invention is a composite construction which is formed by integrally combining packings 3 and masses 4, i.e. two members different in texture. The formed packing ring 2 not only exhibits excellent leakproofness as described above but also permits easy handling and simple maintenance owing to such fastness of the composition of component members such that the upper and the lower surfaces of the packing ring 2 neither sustain injury nor separate vertically from each other.

The packing ring 2 acquires the optimum sealing property if the density of the packing 3 is set at about 1.3 g/cc and the density of the annular masses 4 is set at a level lower than that of the packing 3, but equal to or higher than about 0.7 g/cc. The packing ring 2, therefore, neither deforms nor fractures in the process of compression moulding and the produced packing ring 2 sustains injury only with difficulty.

Further, the possibility that the packing 3 will protrude through the gap L between the bottom part of the stuffing box 8 and the stem 6, the gap M between the gland retainer 9 and the stem 6 and the gap N between the gland retainer 9 and the stuffing box 8 can be precluded by the annular masses 4 of superposed sheets of expanded graphite. Incidentally, the problem of this protrusion in the examples illustrated in Figures 15 and 16 can be solved substantially completely by causing the packing 5 formed by braiding a knitting yarn of expanded graphite to be driven into the upper and lower ends of the stuffing box 8, i.e. an empty space for accommodation of packing rings, which are not completely closed.

In producing either the packings 3 or the annular masses 4, tolerance in height and diameter is produced among the packings 3 or annular masses 4. When an annular mass 4 has been incorporated into a packing 3 by compression moulding into a packing ring 2, there are some cases, due to the tolerance, where a packed part 10 of the packing 3

consequently formed has a projection (not shown) slightly extending in the axial direction of the packing ring 2 and where the annular mass 4 has a moderate slope (not shown). When such packing rings 2 are set in place inside the stuffing box 8 and compressed by the gland retainer 9, the projection and slope are tightened to induce stress in the radial direction, thereby obtaining a large sealing effect.

The seal device 1 illustrated in Figures 15 or 16, comprising a total of three superposed packing rings 2 formed of expanded graphite of a relatively small friction coefficient relative to the stem 6 in the shape illustrated in Figures 1 and 2 or in the shape illustrated in Figure 3 and packing rings 5 formed by braiding a knitting yarn of expanded graphite and adjoined one each to the opposite end parts of the superposed packing rings 2 proves very effective.

To confirm the sealing effect of the seal devices of this invention, three samples, namely a seal device having packing rings disposed as illustrated in Figures 15 or 16 (hereinafter referred to as "Product X"), a seal device having conventional packing rings disposed as illustrated in Figure 18 (hereinafter referred to as "Product Y"), and a seal device simply combining five packing rings obtained by spirally winding a ribbon of expanded graphite into a roll and compression moulding the roll (hereinafter referred to as "Product Z"), were tested for appropriate tightening stress determined in terms of the tolerable leakage. The conditions under which the test was carried out and the procedure which was adopted for the test are specified as follows.

Nominal dimension of each of Products X, Y and Z:

24 mm x 37 mm x 6.5 mm.

Tightening stress:

100 kgf/cm^2 at the beginning and successively increased every 50 kgf/cm^2.

Fluid sealed:

He gas having a pressure of 52.7 kgf/cm^2.

Temperature:

Room temperature (23 ° C ± 1 ° C).

Leakage measuring apparatus:

A He gas leakage detector.

Concentration of tolerable leakage of He gas:

80 ppm (not more than 0.001 cc/min in terms of the amount of He gas leaked).

Procedure:

After the tightening stress of a gland retainer was set at 100 kgf/cm^2, a valve was loaded with He gas and, ten minutes after the loading, the amount of He gas leaked was measured. This was repeated after the tightening stress was increased by 50 kgf/cm^2 per procedure.

The results of this test were as shown in the characteristic curves of Figure 17 plotting the results of the test for appropriate tightening stress. It is clearly noted from the characteristic diagram of Figure 17 that the appropriate tightening stress of Product X of this invention for the tolerable leakage is as small as 170 kgf/cm^2. In contrast, Product Y and Product Z failed to satisfy the tolerable leakage. The numerals indicated along the vertical axis of Figure 17 represent leakage concentrations (in ppm) reduced from the amounts of leakage by the aspiration method.

As described above, the packing ring of this invention and the seal device using such packing rings of the invention excel in proofness against heat and chemicals and in sealability, completely obstruct leakage of a gas of small molecular weight and a solvent of strong osmosis, preclude protrusion of packing through the gap between a stuffing box and a stem, the gap between a gland retainer and the stuffing box and the gap between the stem and the gland retainer, sustain an injury only with difficulty, and allow the work of maintenance to be carried out easily. They can be applied to a wide variety of valves and other similar devices and utilized for infallibly preventing a fluid from leaking and inducing environmental pollution. Thus, this invention brings about such outstanding effects as described above.

Claims

1. A packing ring (2) characterised by comprising:

a packing (3) obtained by spirally winding a ribbon of expanded graphite into a roll and compression moulding said roll; and

an annular mass (4) of superposed sheets of expanded graphite incorporated into said packing (3) by compression moulding so as to give rise to a composite structure having at least one packed part (10) of increased density in at least one of an inner peripheral part and an outer peripheral part of said packing.

2. A packing ring according to claim 1, characterised in that said packing (3) has a density in the range of 0.7 g/cc to 1.9 g/cc and said annular mass (4) has a density in the range of 0.7 g/cc to 1.9 g/cc.

3. A packing ring according to claim 2, characterised in that said packing (3) has a density in the range of 1.0 g/cc to 1.5 g/cc and said annular mass (4) has a density lower than said density of said packing.

4. A packing ring according to any one of claims 1 to 3, characterised in that said annular mass (4) is incorporated into one of an upper surface

and a lower surface of said packing (3) and extends to said outer peripheral part of said packing to give rise to said packed part (10) in said inner peripheral part of said one surface of said packing.

5. A packing ring according to any one of claims 1 to 3, characterised in that said annular mass (4) is incorporated into one of an upper surface and a lower surface of said packing (3) and extends to said inner peripheral part of said packing to give rise to said packed part (10) in said outer peripheral part of said one surface of said packing.

6. A packing ring according to any one of claims 1 to 3, characterised in that said annular mass (4) is incorporated into one of an upper surface and a lower surface of said packing (3) and extends immediately before said inner peripheral part and said outer peripheral part of said packing to give rise to said packed part (10) in each of said inner peripheral part and said outer peripheral part of said one surface of said packing.

7. A packing ring according to any one of claims 1 to 3, characterised in that said annular mass (4) is incorporated into an intermediate part of said packing (3) and extends to said outer peripheral part of said packing to give rise to said packed part (10) in said inner peripheral part of said intermediate part of said packing.

8. A packing ring according to any one of claims 1 to 3, characterised in that said annular mass (4) is incorporated into an intermediate part of said packing (3) and extends to said inner peripheral part of said packing to give rise to said packed part (10) in said outer peripheral part of said intermediate part of said packing.

9. A packing ring according to any one of claims 1 to 3, characterised in that said annular mass (4) is incorporated into an intermediate part of said packing (3) and extends immediately before said inner peripheral part and said outer peripheral part of said packing to give rise to said packed part (10) in each of said inner peripheral part and said outer peripheral part of said intermediate part of said packing.

10. A packing ring according to claim 4, characterised in that an additional annular mass (4) of superposed sheets of expanded graphite is incorporated into the other of said upper surface and said lower surface of said packing (3) and extends to said outer peripheral part of said packing to give rise to another packed part (10) in said inner peripheral part of said other surface of said packing.

11. A packing ring according to claim 5, characterised in that an additional annular mass (4) of superposed sheets of expanded graphite is incorporated into the other of said upper surface and said lower surface of said packing (3) and extends to said inner peripheral part of said packing to give rise to another packed part (10) in said outer peripheral part of said other surface of said packing.

12. A packing ring according to claim 6, characterised in that an additional annular mass (4) of superposed sheets of expanded graphite is incorporated into the other of said upper surface and said lower surface of said packing (3) and extends immediately before said inner peripheral part and said outer peripheral part of said packing to give rise to another packed part (10) in each of said inner peripheral part and said outer peripheral part of said other surface of said packing.

13. A method for the production of a packing ring, characterised by comprising the steps of:

spirally winding a ribbon of expanded graphite into a roll;

compression moulding said roll into a packing (3);

disposing an annular mass (4) of superposed sheets of expanded graphite at a position in or against said packing; and

compression moulding within a moulding die so as to give rise to a composite structure having at least one packed part (10) of increased density in at least one of an inner peripheral part and an outer peripheral part of said packing.

14. A seal device (1) having an empty space through which a shaft (6) passes, and containing at least one packing ring (2) in said empty space in a compressed fashion to seal between an inner wall of said empty space and an outer peripheral surface of said shaft (6), said at least one packing ring (2) being characterised by comprising a packing (3) obtained by spirally winding a ribbon of expanded graphite into a roll and compression moulding said roll, and an annular mass (4) of superposed sheets of expanded graphite incorporated into said packing (3) by compression moulding so as to give rise to a composite structure having at least one packed part (10) of increased density in at least one of an inner

peripheral part and an outer peripheral part of said packing.

15. A seal device according to claim 14, characterised in that a pair of braided packing rings (5) is provided between which said at least one packing ring (2) is sandwiched, each of said braided packing rings (5) being formed by braiding a knitting yarn of expanded graphite and being accommodated in said empty space.

16. A seal device according to claim 15, characterised in that said at least one packing ring comprises at least one first packing ring and at least one second packing ring superposed one on top of the other,

said first packing ring (2) comprising a packing (3) obtained by spirally winding a ribbon of expanded graphite into a roll and compression moulding said roll and two annular masses (4) of superposed sheets of expanded graphite incorporated one each into an upper surface and a lower surface of said packing (3) and each extending to an outer peripheral part of said packing to give rise to a packed part (10) of increased density in an inner peripheral part of each of said upper surface and said lower surface of said packing, and

said second packing ring (2) comprising a packing (3) obtained by spirally winding a ribbon of expanded graphite into a roll and compression moulding said roll and two annular masses (4) of superposed sheets of expanded graphite incorporated one each into an upper surface and a lower surface of said packing (3) and each extending to an inner peripheral part of said packing to give rise to a packed part (10) of increased density in an outer peripheral part of each of said upper surface and said lower surface of said packing.

17. A seal device according to claim 15, characterised in that said at least one packing ring comprises at least two superposed packing rings (2), each comprising a packing (3) obtained by spirally winding a ribbon of expanded graphite into a roll and compression moulding said roll and two annular masses (4) of superposed sheets of expanded graphite incorporated one each into an upper surface and a lower surface of said packing (3) and each extending immediately before an inner peripheral part and an outer peripheral part of said packing to give rise to a packed part (10) of increased density in each of said inner peripheral part and said outer peripheral part of each of said upper surface and said lower surface of said packing.

18. A seal device according to any one of claims 14 to 17, characterised in that said shaft is a stem (6) of a valve and said empty space is a stuffing box (8) formed between said stem (6) and a body or bonnet (7) of said valve.

19. A seal device according to any one of claims 14 to 17, characterised in that said empty space is formed in a seal portion of a valve.

20. A seal device according to any one of claims 14 to 17, characterised in that said empty space is formed in a shaft seal portion of a pump.

FIG. 1

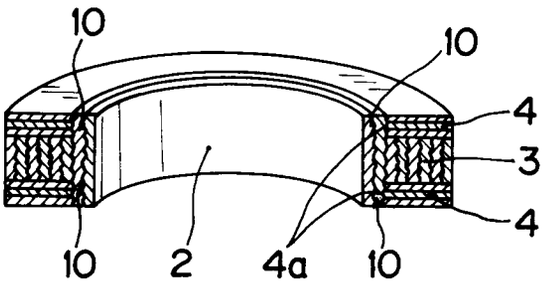


FIG. 2

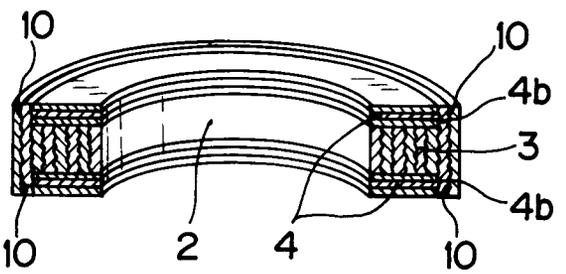


FIG. 3

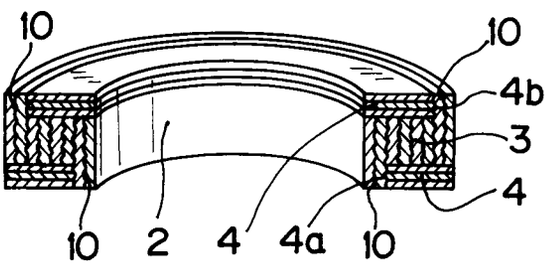


FIG. 4

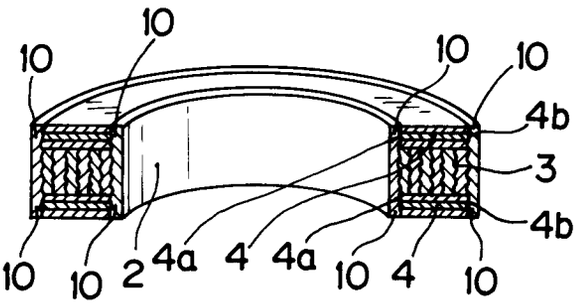


FIG. 5

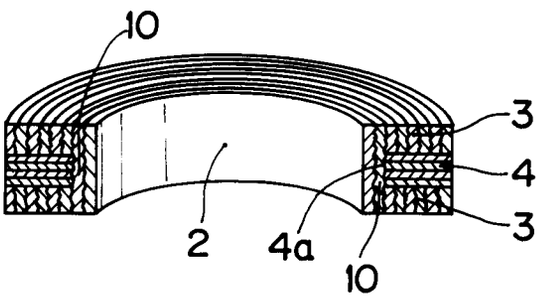


FIG. 6

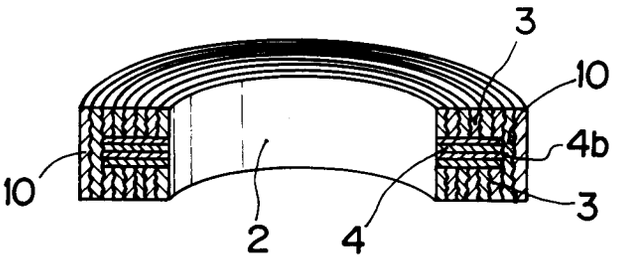


FIG. 7

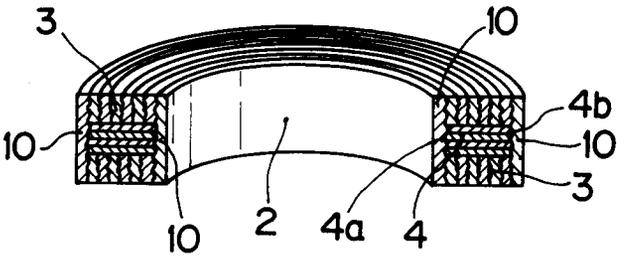


FIG. 8

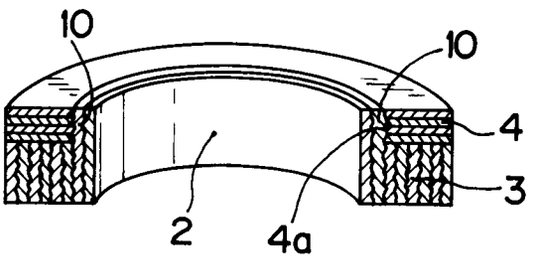


FIG. 9

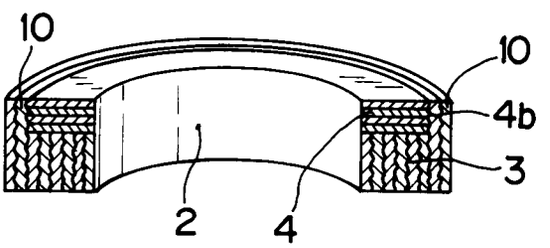


FIG. 10

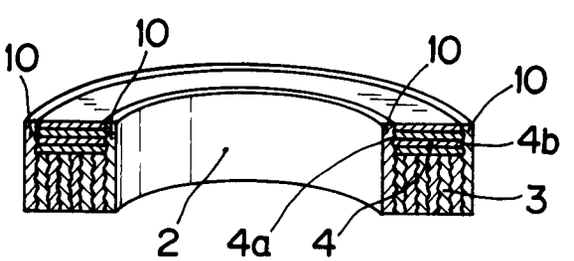


FIG.11

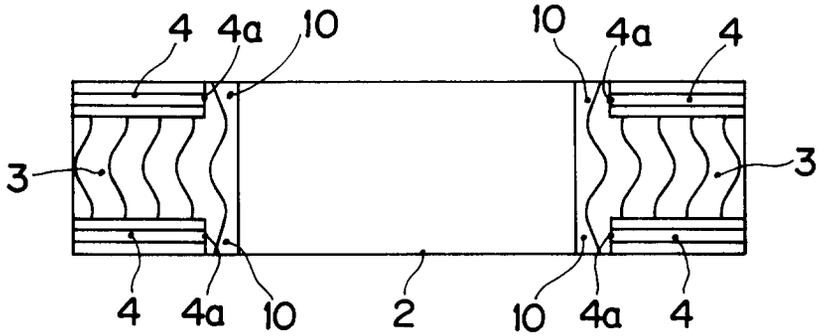


FIG.12

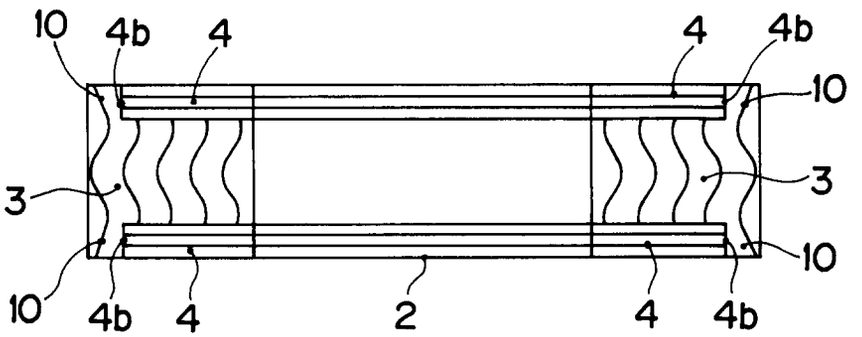


FIG.13

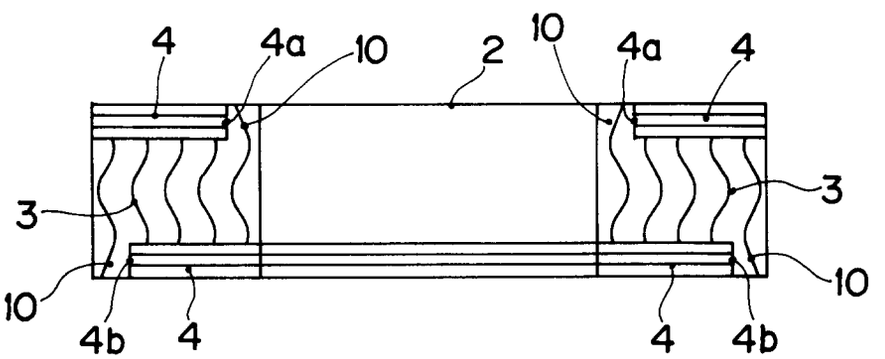


FIG.14

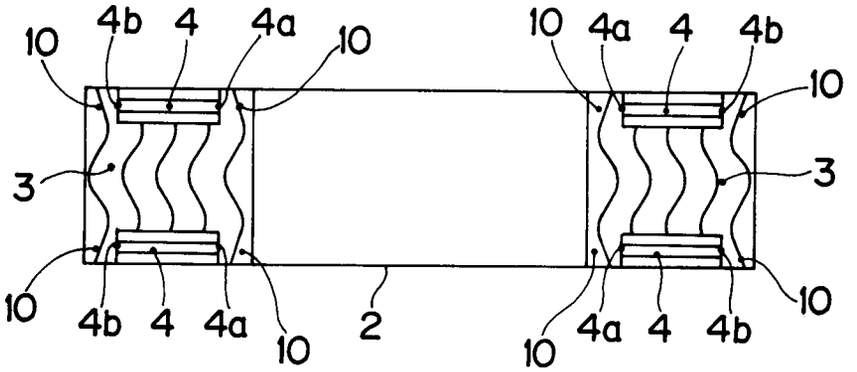

10
4b
4
4a
10
10
4a
4
4b
10
3
3
10
4b
4
4a
10
2
10
4a
4
4b
10

FIG.15

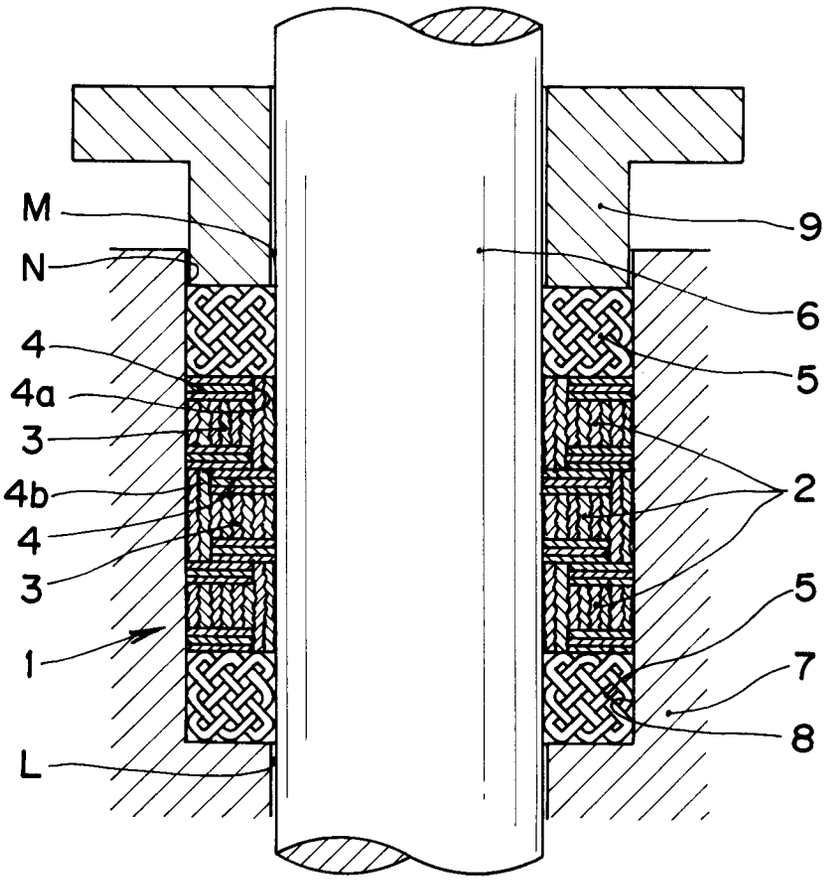

M
N
4
4a
3
4b
4
3
1
L
9
6
5
2
5
7
8

FIG.16

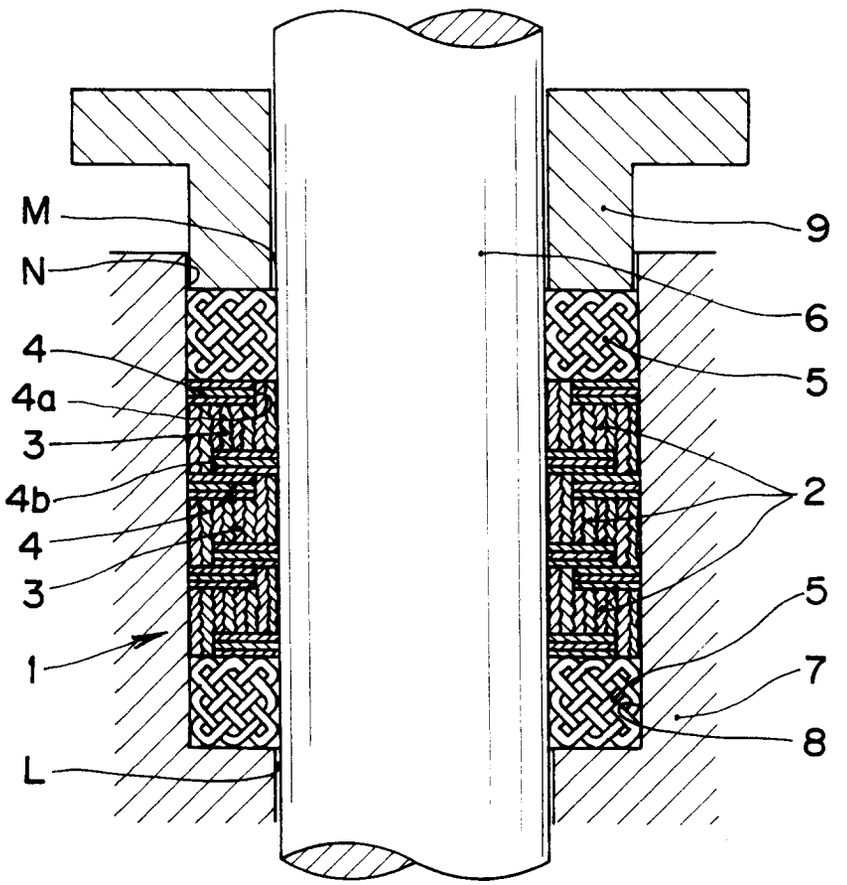


FIG.17

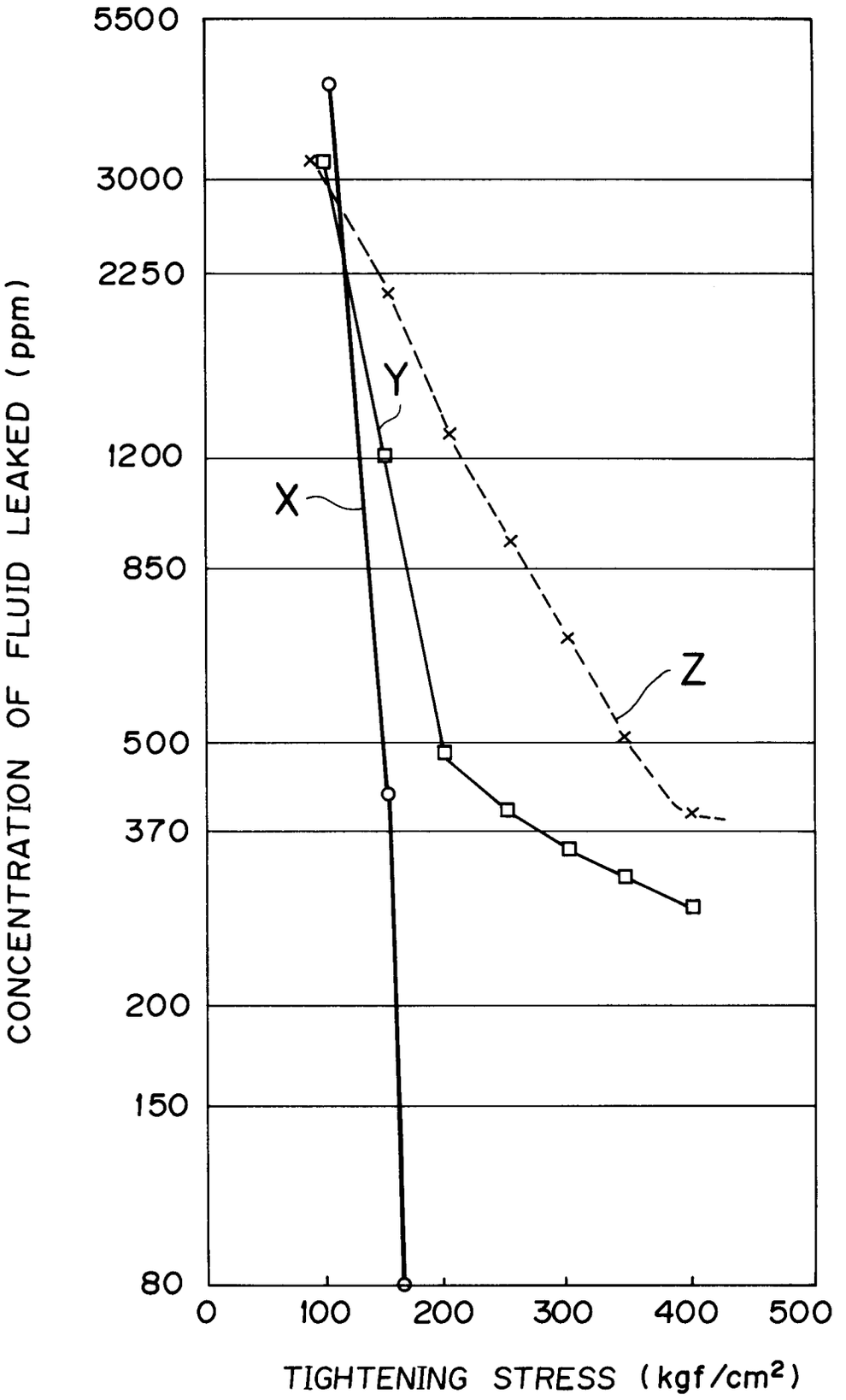
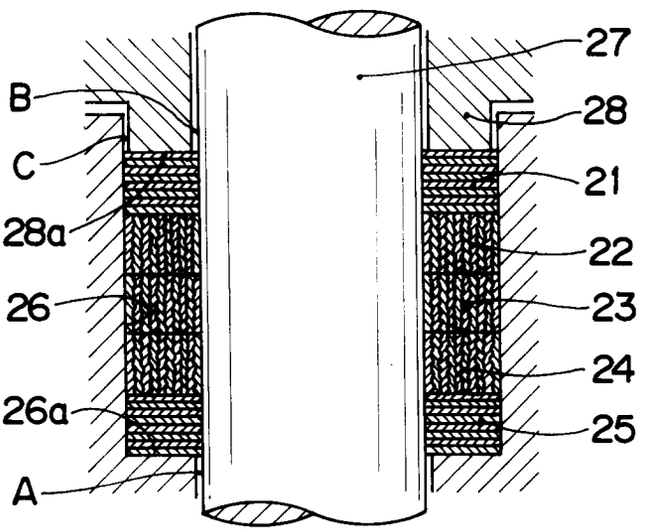

5500
3000
2250
1200
850
500
370
200
150
80
0
100
200
300
400
500
CONCENTRATION OF FLUID LEAKED (ppm)
TIGHTENING STRESS (kgf/cm²)
X
Y
Z

FIG.18



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 4115

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	DE-A-39 04 200 (KEMPCHEN & CO GMBH) * the whole document *	1,4,5	F16J15/30
A	US-A-5 050 298 (A. R. DODSON) * column 3, line 23 - line 68; figures 1,7 *	1	
A	US-A-4 157 835 (O. KAHLE)		
A	US-A-4 826 181 (R.A. HOWARD)		
A	GB-A-2 077 246 (FUKUVI CHEMICAL INDUSTRY CO. LTD.)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
F16J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	19 April 1995	Hoffmann, M

CATEGORY OF CITED DOCUMENTS

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